Does dam removal reverse large dam effects on riparian vegetation?

Testing Predictions on the Elwha River, Washington

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The question:
Will large dam removal restore rivers?
...or will there be unexpected outcomes? How do we find out?
How do dams affect rivers?

**Upstream** → **Impoundment** → **Downstream**

- Block fish passage/marine derived nutrients
- Inundate riparia
- Shift to lake-like habitat
- Trap water, seeds, wood, and sediment
- Reduce sediment, wood, and seed supply
- Alter flood regime
- Human disturbance
Dam Consequences for Downstream Riparian Vegetation

- Riparian surfaces may become “terrestrialized”
  - later successional plant communities
- Reduced recruitment of species that need specific flow regimes
- Less hydrochory
Dam Consequences for Downstream Riparian Vegetation

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= Lower diversity
The question:
Will large dam removal restore rivers?

Elwha River, Image courtesy National Park Service
Elwha River

• Largest dam removal (yet)
Elwha Dam (32 m) 1912-2012

2010

2013
Glines Canyon Dam (64 m) 1912-2015

~1910  2010  2013

Images courtesy National Park Service
Reservoir sediment accumulation (>21 million m³) - driving a decrease in young landforms downstream from dams (Kloehn et al. 2008)

Images courtesy National Park Service, Roger Hoffman
How do dams and dam removal on the Elwha River affect downstream riparian vegetation?

**Predictions:**

- **Below dams:**
  - Fewer young landforms (bars)
  - Fewer native plant species

- **Dam removal:**
  - Will reverse these patterns in the long term
  - But in the short term, heavy sedimentation may reduce diversity
Landform Classification

- Terrace
- Floodplain
- Bar
Vegetation Survey:

• Species percent cover recorded in 100 m² plots stratified by landform in 2005, 2010, 2013, 2014, 2016
• Topographic change, soil depth, & pebble counts recorded in all plots
• Reservoirs surveyed in 2013, 2014
• Soil nutrients and texture analyzed from 2013 samples
Have young landforms increased since dam removal?

Middle Reach: Altair Campground Bridge, Downstream
Have young landforms increased since dam removal?

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How transitory is this sediment?

Middle Reach: Altair Campground Bridge, Downstream
Middle Reach Sediment Deposition in Riparian Zone
- likely to be less transitory (?)

2010

2013

Over 80 cm in back channels!
Note the change in woody debris…

How will this interact with sediment?

Groundwater infiltration?

2007 2014

Middle Reach: at Elwha Campground
Do dams and dam removal affect native species richness?
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~150 species total
Do dams and dam removal affect native species richness?

45% fewer species

~150 species total

Year

2005

2010

Native Species Richness

upper

middle

lower

River Section

~150 species total
Do dams and dam removal affect native species richness?

~150 species total
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~150 species total

Tukey Test P = 0.08
What about nonnative species?
Willow and cottonwood seedling recruitment in downstream reaches
Summary

• Before removal: 45% fewer plant species downstream from dams

• 3 years after removal: more young landforms and possibly more species….

• Long-term?
Lessons for other dam removals

- Dam removal affects the entire riverine ecosystem and can create transitory impacts.

- Even without altered flow regimes, dams can have big impacts due to altered sediment supply.

- Understanding short term vs. long term effects requires long-term monitoring (decades).

- Rivers are dynamic! Assessing change to dynamics requires long-term monitoring both before and after.
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